

The amount of fuel (excluding liquid fuel) consumed annually in the industrial area of the city is estimated at about 17½ million tons, and includes anthracite, coke, and bituminous coal, the last representing nearly one-half of the total. The following figures are given, though, as all experimental details are omitted, it is impossible to comment on the method by which they have been ascertained:—

Source	Coal consumed, tons	Average loss per cent.	Loss in tons	Percentage of total loss
Steam locomotives ...	2,099,044	1·084	22,750	7·47
Steam vessels ...	81,375	1·233	995	0·33
High-pressure boilers and public buildings	7,316,257	0·805	58,867	19·34
Low-pressure boilers and private houses...	4,154,746	0·630	26,180	8·60
Gas and coke plant ...	234,551	—	—	—
Metallurgical and other furnaces ...	3,696,550	5·291	195,599	64·26
	17,582,523	1·808	304,391	100·00

The author discusses the causes of imperfect combustion and the best means of ameliorating the output of smoke; but as these are generally well known and recognised, at least in theory, they need not be reproduced. That smoke abatement is nearly always an indirect means of effecting economy is another well-established fact to which he refers. Dr. Goss points out the interesting observation, which may not be generally known, that the visibility or otherwise of smoke has no direct relation to its content of solid matter. The adoption of anthracite coal or coke as fuel will serve to render the discharge less visible, but will not eliminate the emission of dust or fine cinder. He appears to think that the replacement of coal by electrical energy will not reduce the amount of visible smoke to any serious extent, for steam raising will still be necessary. The more extensive use of gaseous fuel, smoke-washing, and electrical precipitation of smoke as a means of smoke abatement are passed over, for some unexplained reason, as not within the scope of the paper.

The author is not very optimistic in his outlook, for he considers that a revolution in practice which will result in the elimination of existing sources of atmospheric pollution is not to be expected "because present-day knowledge is insufficient to supply the necessary means, and, second, because the immediate application to all sources of pollution, even of such means as are now available, is mechanically and financially impracticable."

If by this statement Dr. Goss includes all forms of atmospheric pollution such as arise from gaseous impurities and dust particles blown into the air from the streets, etc., no doubt he is right; but he has himself shown that gaseous impurities are minimal in quantity, because they are rapidly dispersed, whilst dust particles, which exist everywhere, have never been regarded as causing injury either to animal or plant life.

But the really harmful constituents of a town atmosphere are unequivocally derived from one source—the incomplete combustion of coal, and there are few people who have studied the question in this country who are not thoroughly convinced that the pressure of properly instructed and firm control, supported by adequate legal penalties and the force of intelligent public opinion, would rapidly diminish and eventually eliminate an evil for which no economic or, indeed, any other excuse can exist. We are throwing away in a wanton and criminal fashion, without let or hindrance, a valuable inheritance which should belong to coming generations, and which they will never be able to recover.

J. B. C.

MAN AS A MACHINE.¹

(1) A NUMBER of different experimental methods for determining the respiratory exchange of man have been employed in the past, some of which are designed for long experiments and some for short, and of late years it has become evident that a critical examination ought to be made with the view of determining how far the different methods give trustworthy and comparable results. A comparison of this kind involves very great labour, and Dr. Carpenter is to be congratulated on having undertaken the work. His investigation is throughout characterised by that careful attention to detail that we have learnt to associate with the Nutrition Laboratory at Boston of the Carnegie Institution.

The experimental methods examined in detail are the bed respiration calorimeter described by Benedict and Carpento, two types of the Benedict universal respiration apparatus, and the apparatuses described by Zuntz and Geppert (the absence of the portable apparatus of Zuntz is perhaps a matter for regret), by Tissot and by Douglas. In addition, there is a description of accessory apparatus, including the Haldane gas analysis apparatus.

The experiments were made on resting subjects twelve hours or more after their last meal. In each experiment two of the different forms of apparatus were used either alternately or in series, the periods following each other as rapidly as possible. The three forms of Benedict apparatus were compared with one another, and the other methods were compared with the Benedict universal apparatus. Full tables of results are given, and these show that there is a wonderfully close agreement between the average figures obtained by the different methods.

In a critical discussion the author deals with the possible sources of error, as well as with the advantages and disadvantages of each of the methods.

In general comparable results can be obtained with all the methods investigated if care is taken, but preference is given to the Benedict apparatus, mainly on the ground that it is possible to obtain trustworthy results more quickly with it than with methods which involve volumetric gas analysis.

It would have lent additional interest to this discussion if a few comparative experiments could have been made during muscular work, as it is possible that some additional sources of error or inconvenience may become apparent when the different forms of apparatus are called upon to deal with a greatly increased respiratory exchange.

(2) The authors confine themselves in this publication to the calculation from the total respiratory exchange of the actual amount of energy liberated in the human body during walking exercise, but it is their intention to extend their observations in the future by means of direct calorimetry. An admirable introduction is afforded by an account of the previous history of the subject, amplified by an extensive table giving a complete summary of the results of previous observations.

The research has been conducted throughout in the laboratory on two athletic subjects. An ingenious form of horizontal treadmill is described, on which the subject walks at different paces, while the respiratory exchange is measured by means of the Benedict universal apparatus, various devices being employed for recording automatically the distance traversed, the number of steps taken, and the height through which the body is raised at each step.

¹ (1) "A Comparison of Methods for Determining the Respiratory Exchange of Man." By T. M. Carpenter. Pp. 265. (Publication No. 216 of the Carnegie Institution of Washington.) Price 2.50 dollars.

(2) "Energy Transformations during Horizontal Walking." By F. G. Benedict and H. Morschhauser. Pp. 100. (Publication No. 231 of the Carnegie Institution of Washington.) Price 1 dollar.

In attempting to estimate correctly the amount of energy used for the actual forward progression of the body it is essential to deduct from the total measured energy output a fraction which will represent what may be termed the basal maintenance metabolism, and it is somewhat difficult to decide what value to take for this purpose. The authors on the whole prefer to take as this basis the energy output found when the subject is standing still with the muscles relaxed, and this value certainly appears more reasonable than that found when the subject is lying at rest, though the latter has been used frequently by earlier workers on the subject. They have, however, considered other possible bases, especially with reference to walking at a very fast pace when pronounced movements of the arms occur.

With one of the subjects the pace was limited to slightly under three miles an hour, but with the other it was varied widely, ranging, roughly, from two and a half to five and a half miles an hour. As the pace increases the amount of energy output to move one kilo of the body weight one metre horizontally increases very greatly, as other observers have found.

Some experiments performed with the subject running showed that it was more economical of energy to run than to walk at the rate of more than five miles an hour.

In examining the influence of food on the energy output during the exercise, the authors find that the increase in the metabolism due to the walking is at any given pace in the main constant and merely superimposed on the increased resting metabolism due to the food. With a large protein diet there is evidence that the heat output per unit of work is increased. Apart from the question of the absolute expenditure of energy, the figures in the various tables will be of extreme interest to any who wish to study the character of the metabolism during muscular exertion.

C. G. D.

THE GRAVELS OF EAST ANGLIA.

THE Cambridge University Press has published two interesting geological pamphlets by Prof. T. McKenny Hughes, the first on "The Gravels of East Anglia" (price 1s.), the second entitled "Notes on the Fenland," with a description of the Shippea man by Prof. A. Macalister (price 6d.). The gravels of East Anglia are especially useful in any inquiry as to the age and origin of the superficial deposits of our country, because of their wide distribution and the long continuous sections on the coast, in which many of them may be studied. They consist for the most part of subangular flints, which cannot have been derived directly from the chalk, and Prof. Hughes concludes that they are the débris of an old Miocene land-surface on which the chalk with flints was exposed. After a well-illustrated account of many sections, and a brief discussion of the mammalian remains found in the gravels and associated deposits, Prof. Hughes summarises the sequence of phases in the later geological history of East Anglia as he now understands them. All these gravels are of Pleistocene age, but the marsh-deposits of the fenland are distinctly later. They contain remains of the brown bear and the beaver, which survived in England until historic times, but none of the typical Pleistocene mammalia; while the most remarkable of the birds is the pelican. There is no definite chronological succession which will hold throughout the fens, and the relative dates of the various remains found in them cannot be well determined. The human skull and associated remains from Shippea Hill, described by Prof. Macalister, may be quite modern, though perhaps as old as the Bronze age.

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THE ORGANISATION OF INDUSTRIAL SCIENTIFIC RESEARCH.¹

II.

IT is the common opinion of those who have to deal with the organisation of research that only a small percentage of all the investigations started are likely to be successful, the great majority being either dropped before they come to an end, or, being carried through, are filed simply as records, without any results having been obtained which would justify the expense of the investigation; that is to say, industrial research is justified only by the great value of the successful attempts, and these must bear the burden of a great number of unsuccessful attempts, which may have been quite as costly as the successful ones themselves. Naturally, the object of organisation is to attempt to reduce the proportion of unsuccessful investigations which will be undertaken, as has already been shown. This can be done by increasing the size of the laboratory, by increasing the specialisation of the workers, and especially by increasing co-operation between workers in different fields.

Naturally, the most important step which could be taken to increase the efficiency of industrial research would be to increase the likelihood of correct choice of a promising investigation, but, unfortunately, very little can be done in this direction. Those with the most experience in research work are all agreed that it is almost impossible to say whether a given investigation will prove remunerative or not. The only general conclusion that can be drawn is that the deeper a given investigation goes towards the fundamentals of the problem the more likelihood there is that the results will be of value, and the more superficial an investigation is, even although it appears more promising at first sight, the less likelihood there is that it will finally prove of real worth, so that the choice of investigations must necessarily be made largely at random, and will be influenced to a great extent by the ideas of the scientific workers themselves; if any worker has a desire to take up any particular line of work, provided that it is associated with the general trend of work in the laboratory, it is usually wise to let him do so, but the expedition with which a decision can be reached as to the probable value of the investigation after it has been started is very greatly enhanced by the complete co-operation of workers in the different branches of science in consultation on the problem.

At this point it might be well to discuss the organisation of a large research laboratory. Such a laboratory should be established in charge of a director who has had some actual manufacturing experience in the works processes, but at the same time he must have a considerable sympathy with purely scientific work and an interest in the advancement of scientific theory. Both these qualifications are desirable, but if such a director combining the two cannot be found, then a man of full scientific training should be chosen and put into a position of responsibility in the manufacturing side of the industry until he has become fully acquainted with the technique of the industry. It is most inadvisable to take a man from the industry who has not had a full scientific training, including advanced research work in academic problems, since he will generally be lacking in sufficient knowledge of, and sympathy with, the more academic investigations of which he will be in charge, and if the two necessary qualifications cannot be found united in one man, it will be necessary to take a man with the scientific

¹ An address delivered at Columbia University by Dr. C. E. Kenneth Mears, director of the Research Laboratory, Eastman Kodak Co. Rochester N.Y. Continued from p. 413.